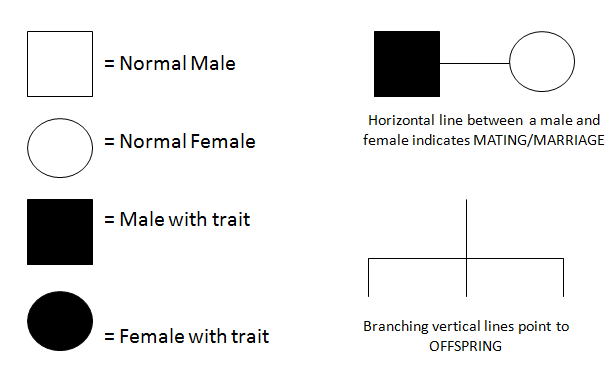
Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

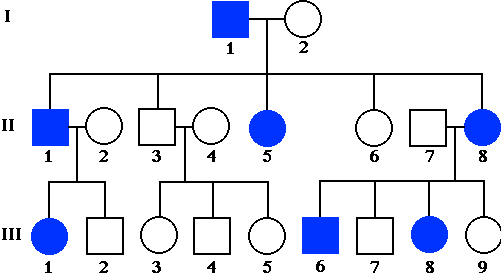
**Unit 7, Part 4 Notes: Pedigrees**

Pre-AP Biology Mrs. Krouse

1. **How can we track the inheritance of a trait through multiple generations?**
2. Scientists use pedigree charts to track the inheritance of a trait through multiple generations. You need to be able to analyze existing pedigrees and create pedigrees from information you are given about a family’s traits.
3. Below is a summary of the symbols used in a pedigree chart…



1. The generations of a pedigree (ex: grandparents, parents, and children) are typically labeled with roman numerals (I, II, III, IV, V, etc.) Within a generation, each person (from left to right) are typically labeled with a number (1, 2, 3, 4, 5, etc.). The pedigree given below shows this labeling system.



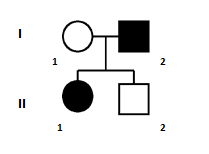
1. **What types of traits are shown in pedigrees?**

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1. Autosomal dominant traits are controlled by a dominant allele on an autosome (a non-sex chromosome). For example, the allele for a widow’s peak hairline is dominant to the allele for a straight hairline (see images to the right).
2. For autosomal dominant traits, we use the following alleles, which result in the following genotypes and phenotypes. (Note: I have randomly chosen the letter “A” for these alleles. We could use any letter in the alphabet.)

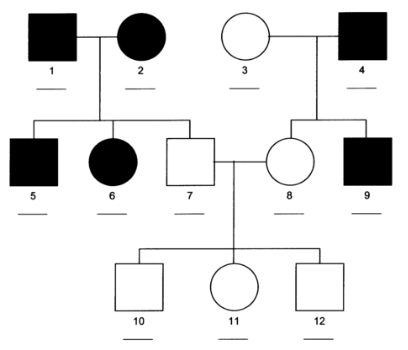
|  |  |  |  |
| --- | --- | --- | --- |
| **Alleles** | **Genotype** | **Phenotype** | |
| A = trait (ex: widow’s peak)  a = normal (ex: straight hairline) | AA | Trait |
| Aa |
| aa | Normal |

1. The pedigree shown below could be used to show the inheritance of an autosomal dominant trait. The genotypes of each person are shown below the pedigree with an explanation for how I (Mrs. Krouse) determined the genotypes.

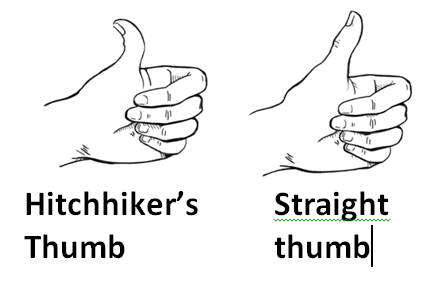


* I-I and II-2: The mother (I-1) and son (II-2) must have the genotype “aa” because they are normal (do not have the trait). With an autosomal dominant trait, the only genotype that can give a person the normal (non-trait) phenotype is the homozygous recessive genotype (aa).
* I-2: The father must have the genotype “Aa”. He must have at least one “A” allele because he shows the trait. His other allele must be “a” because his son (II-2) has the genotype “aa.” A child receives one allele from each parent, so the son must have received one “a” allele from his mother and the other “a” allele from his father.
* II-2: The daughter must have the genotype “A.” She must have at least one “A” allele because she shows the trait. Her other allele must be “a” because she received one allele from each parent. Her mother could only give her an “a” allele.

1. Let’s try an example problem. Identify the genotypes of each person shown in the pedigree to the right by writing the genotype (AA, Aa, or aa) below the symbol (circle or square) for each person. The pedigree shows the inheritance of face freckles, which is an autosomal dominant trait.



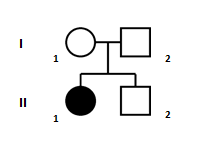
For some people in the pedigree, it may be impossible to tell whether their genotype is homozygous dominant (AA) or heterozygous (Aa). For these people, write both genotypes (AA and Aa) below their symbol (circle or square).

1. Autosomal recessive traits are controlled by a recessive allele on an autosome. For example, the allele for hitchhiker’s thumb is recessive to the allele for straight thumb (see image to the right).

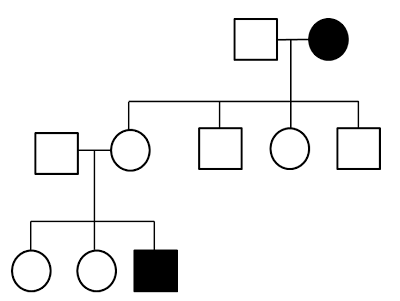
1. For autosomal recessive traits, we use the following alleles, which result in the following genotypes and phenotypes. (Note: I have randomly chosen the letter “A” for these alleles. We could use any letter in the alphabet.)

|  |  |  |
| --- | --- | --- |
| **Alleles** | **Genotype** | **Phenotype** |
| A = normal (ex: straight thumb)  a = trait (ex: hitchhiker’s thumb) | AA | Normal |
| Aa |
| aa | Trait |

1. The pedigree shown below could be used to show the inheritance of an autosomal recessive trait. The genotypes of each person are shown below the pedigree with an explanation for how I (Mrs. Krouse) determined the genotypes.



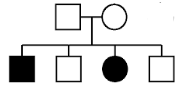
* II-1: The daughter has the genotype “aa” because she displays the trait. With an autosomal recessive trait, the only genotype that can give a person the trait is the homozygous recessive genotype (aa).
* I-1 and I-2: The mother (I-1) and father (I-2) must have the genotype “Aa.” The must have at least one “A” allele because they are normal (do not show the trait). Their other allele must be “a” because their daughter (II-1) has the genotype “aa.” She had to receive one “a” allele from each parent.
* II-2: The son could have the genotype “AA” or the genotype “Aa.” He must have at least one “A” because he is normal (does not show the trait), but we can’t determine what the other allele is (either “A” or “a”). He could have received a “A” allele from both parents. Or he could have received an “A” allele from one parent and an “a” allele from the other parent.



1. Let’s try an example problem. Identify the genotypes of each person shown in the pedigree to the right by writing the genotype (AA, Aa, or aa) below the symbol (circle or square) for each person. The pedigree shows the inheritance of cystic fibrosis, which is a disease caused by an autosomal recessive allele.

For some people in the pedigree, it may be impossible to tell whether their genotype is homozygous dominant (AA) or heterozygous (Aa). For these people, write both genotypes (AA and Aa) below their symbol (circle or square).

1. For the autosomal recessive pedigree shown below, the two parents must have the genotype “Aa.” We know this because they have two children who show the trait (i.e., the first son and the daughter). These children must have the genotype “aa,” meaning they must have received an “a” allele from each parent.



For two parents with the genotype “Aa,” we could set up a Punnett square (see below) to predict the genotype and phenotype frequencies of their children.

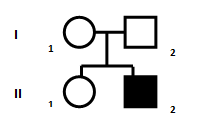
|  |  |  |
| --- | --- | --- |
|  | A | a |
| A | AA | Aa |
| a | Aa | aa |

According to the Punnett square, we would expect 3/4 of their children to be normal and 1/4 of their children to show the trait. It is important to remember that these are just predicted frequencies. In a real family, it would be completely possible (though less likely) for the couple to have children with different phenotype frequencies than those predicted by the Punnett square. For example, in a real family, the couple could have all normal children or all children with the trait. In the pedigree above, two of the couple’s children show the trait, and the other two do not.

1. X-linked recessive traits are controlled by a recessive allele on the X chromosome. Pedigrees that follow this method of inheritance will show more males with the trait than females. This is because males only need to receive one copy of the recessive allele to show the trait (because they only have one X chromosome). In contrast, females must receive two copies of the recessive allele to show the trait. An example of an X-linked recessive trait is red-green color blindness.
2. For X-linked recessive traits, we use the following alleles, which result in the following genotypes and phenotypes. (Note: I have randomly chosen the letter “A” for these alleles. We could use any letter in the alphabet.) Remember, we use X’s to indicate that the trait is found on the X chromosome.

|  |  |  |
| --- | --- | --- |
| **Alleles** | **Genotype** | **Phenotype** |
| XA = normal (ex: normal color vision)  Xa = trait (ex: red-green color blindness) | XAXA or XAXa | Female, Normal |
| XaXa | Female, Trait |
| XAY | Male, Normal |
| XaY | Male, Trait |

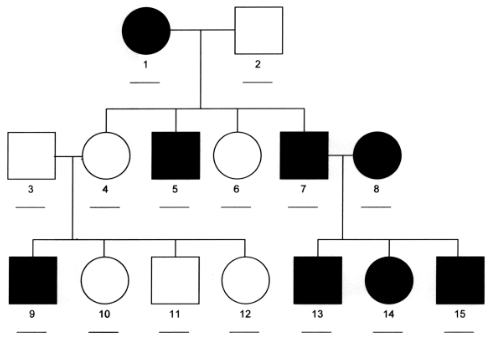
1. The pedigree shown below could be used to show the inheritance of an x-linked recessive trait. The genotypes of each person are shown at the top of the next page with an explanation for how I (Mrs. Krouse) determined the genotypes.



* I-2: The father has the genotype XAY. He has the sex chromosomes “XY” because he is male. The “A” on his X chromosome indicates that he does not show the trait. There is no “A” on his Y chromosome because the gene is X-linked, so it is found on the X chromosome, not the Y chromosome.
* II-2: The son has the genotype XaY. He has the sex chromosomes “XY” because he is male. The “a” on his X chromosome indicates that he shows the trait.
* I-1: The mother has the genotype XAXa. She must have at least one XA allele because she does not show the trait. Her other allele must be Xa because she had to give an Xa to her son (II-2). It is important to remember that sons always inherit their Y chromosome from their father and their X chromosome from their mother.
* II-1: The daughter could have the genotype XAXA or XAXa. She must have at least one XA allele because she does not show the trait. Her other allele could be XA or Xa. She could have inherited an XA allele from both parents, or she could have inherited an XA allele from her father and an Xa allele from her mother.

1. Let’s try an example problem. Identify the genotypes of each person shown in the pedigree to the right by writing the genotype below the symbol (circle or square) for each person. The pedigree shows the inheritance of hemophilia, which is a disease caused by an X-linked recessive allele.

For some females in the pedigree, it may be impossible to tell whether their genotype is XAXA or XAXa. For these females, write both genotypes (XAXA and XAXa) below their symbol (circle).

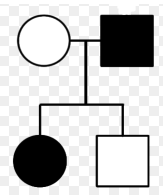
When filling in genotypes for X-linked recessive pedigrees, I suggest writing in XX for females and XY for males before adding any A’s. I also suggest determining the A’s that go on male X chromosomes before doing this for female X chromosomes. It is easier to determine the A’s that go on male X chromosomes because whatever “A” allele they have is shown in their phenotype (because they only have one!)

1. X-linked dominant traits are controlled by a dominant allele on the X chromosome. Unlike X-linked recessive traits, X-linked dominant traits are not more common in males. With X-linked dominant traits, both males and females only need to receive one copy of the X-linked dominant allele (XA) to show the trait. An example of a disease caused by an X-linked dominant allele is rickets.

1. For X-linked dominant traits, we use the following alleles, which result in the following genotypes and phenotypes. (Note: I have randomly chosen the letter “A” for these alleles. We could use any letter in the alphabet.) Remember, we use X’s to indicate that the trait is found on the X chromosome.

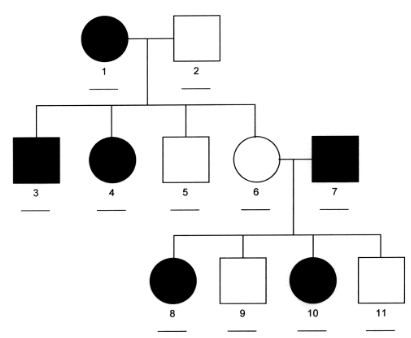
|  |  |  |
| --- | --- | --- |
| **Alleles** | **Genotype** | **Phenotype** |
| XA = trait (ex: rickets)  Xa = trait (ex: normal) | XAXA or XAXa | Female, trait |
| XaXa | Female, normal |
| XAY | Male, trait |
| XaY | Male, normal |

1. The pedigree shown below could be used to show the inheritance of an X-linked dominant trait. The genotypes of each person are shown below with an explanation for how I (Mrs. Krouse) determined the genotypes.



* The father (sorry the generations and people within each generation are not labeled) must have the genotype XAY because he shows the trait.
* The son must have the genotype XaY because he does not show the trait.
* The mother must have the genotype XaXa because she is normal (does not show the trait).
* The daughter must have the genotype XAXa. She must have one XA allele, which she inherited from her father, because she shows the trait. Her other allele must be Xa because she receives one X chromosome from each parent, and her mother could only give her an Xa allele.

1. Let’s try an example problem. Identify the genotypes of each person shown in the pedigree to the right by writing the genotype below the symbol (circle or square) for each person. The pedigree shows the inheritance of Rett syndrome, which is a disease caused by an X-linked dominant allele.



For some females in the pedigree, it may be impossible to tell whether their genotype is XAXA or XAXa. For these females, write both genotypes (XAXA and XAXa) below their symbol (circle).

When filling in genotypes for X-linked dominant pedigrees, I suggest writing in XX for females and XY for males before adding any A’s.

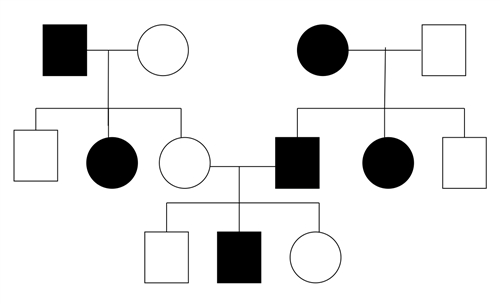
1. **What types of questions might I be asked about pedigrees on a test?**
2. On a test, you may be told that a trait show in a pedigree displays a particular type (pattern) of inheritance (i.e., autosomal dominant, autosomal recessive, X-linked dominant, or X-linked recessive). If given this information, you may be asked to determine the genotypes of particular people within a pedigree. We have already practiced this in Part B (#4, 8, 13, and 17).
3. On a test, you may also be asked if a trait shown in a pedigree displays a recessive pattern of inheritance or a dominant pattern of inheritance.

* If the trait shown in the pedigree “skips generations,” then the pedigree shows a recessive pattern of inheritance (either autosomal recessive or X-linked recessive). By “skip generations,” I mean there are one or more places in the pedigree where a child shows the trait but neither parent shows the trait.
* If the trait shown in the pedigree does not skip generations, then the pedigree shows a dominant pattern of inheritance (either autosomal dominant or X-linked dominant). By “does not skip generations,” I mean that any time a child in the pedigree shows the trait, at least one of the parents shows the trait.

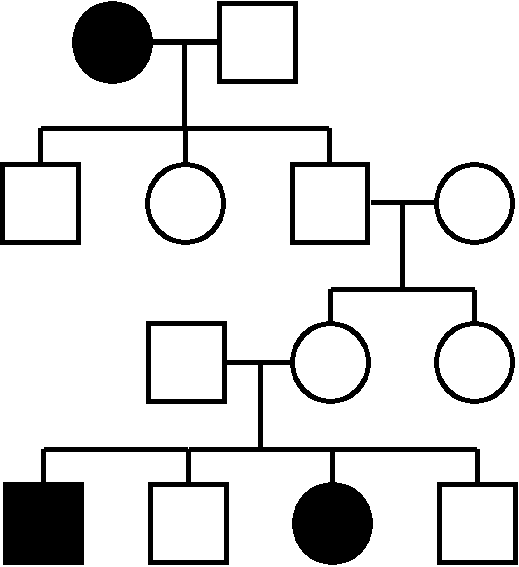
1. On a test, you may also be asked if a trait shown in a pedigree displays an autosomal or X-linked pattern of inheritance.

* If the trait is seen in approximately the same number of males and females in the pedigree, then the trait most likely shows an autosomal pattern of inheritance.
* If the trait is seen in significantly more males than females in the pedigree, then the trait most likely shows an X-linked pattern of inheritance (specifically an X-linked recessive pattern of inheritance).

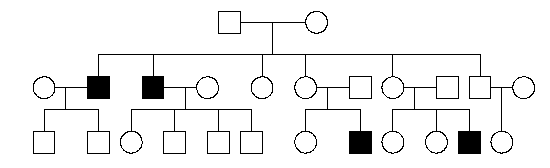
1. Sample Question: Does the pedigree shown below show a dominant or recessive pattern of inheritance? Does it show an autosomal or X-linked pattern of inheritance?



1. Sample Question: Does the pedigree shown below show a dominant or recessive pattern of inheritance? Does it shown an autosomal or X-linked pattern of inheritance?



1. Sample Question: Does the pedigree shown below show a dominant or recessive pattern of inheritance? Does it shown an autosomal or X-linked pattern of inheritance?



1. On a test, you may also be asked to draw a pedigree if given information about the members of a family. For example, I’d like you to draw a pedigree to track the inheritance of albinism through a family given the information provided below. Albinism is a condition in which a person lacks skin pigmentation.

One couple has a son and a daughter with normal pigmentation. Another couple has one son and two daughters with normal pigmentation. The daughter from the first couple has three children with the son of the second couple. Their son and one daughter have albinism; their other daughter has normal pigmentation.